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there are great desert areas, and there are also great areas where limestone rock does not occur. And most of these, whether fissured or not, have experienced a quite different development of land forms than those that have been so constantly visited by Martel and have so impressed themselves upon his mind.

One has only unqualified admiration for Martel's courage in making underground explorations that few have dared to make. He has gathered original material from really dangerous sources. In his devoted quest for facts he has never allowed himself to be defeated by conditions, however perilous.

The Physiography of Shore Lines

D. W. Johnson. **Shore Processes and Shoreline Development.** xvii and 584 pp.; maps, diagrs., ills., bibliogr., indexes. John Wiley & Sons, Inc., New York, 1919. $5.00. 9 x 6 inches.

Major Johnson's book is a most noteworthy contribution to the science of physiography, presenting for the first time a full systematic discussion of shore-line development, a subject to which Gilbert, Davis, Gulliver, Jefferson, Abbe, and some others in our own country have made valuable contributions.

The opening chapter of the book treats of water waves, and presents to the reader a brief survey of the literature on the subject, "which may be useful in showing the growth of our knowledge of waves since the time of Leonardo da Vinci." Waves of oscillation, waves of translation, earthquake and explosive waves, and tidal waves all find adequate treatment; such features as wave motion, wave form, wave height, wave length, and wave velocity being carefully worked out. Some notion of the painstaking care bestowed upon the work may be gained when it is noted that the sources on which the author has drawn include nearly two hundred titles given under 168 numbered references at the close of the first chapter. The chapter on the work of waves discusses wave energy, the nature of wave attack, measurements of wave energy, the damage done by storm waves, conditions affecting wave energy, wave refraction, and depth of wave action. The chapters begin with an advance summary and close with a *résumé* followed by a full bibliography. The plan is admirable, and the author's following of it is thoroughly satisfactory.

The transportation of shore débris by many different kinds of currents receives adequate treatment in the author's consideration of the many different types of currents, as wave currents, tidal currents, wind currents, planetary currents, pressure currents, convection currents, salinity currents, and river currents, including also reaction currents, eddy currents, and hydraulic currents (the "polarization currents" of Cornish). This chapter must prove of especial interest to the geologist and the engineer. The harbor engineer is all too prone to believe that the forces operating on the shore line are among the forces of nature that "are subject to no calculation." Work of this kind, however, should make him hopeful that some coming generation may predict shore changes and plan harbor and coast defenses with an assurance wholly unknown today. The references at the close of this chapter present an interesting bibliography, indicating a wide interest in and extensive literature on this subject.

One chapter is devoted to the terminology and classification of shore lines, on which subject Gulliver, J. W. Gregory, Davis, Suess, von Richthofen, Penck, and others have published important papers. Professor Johnson distinguishes shore lines due to submergence from those due to emergence, and he finds that there are neutral shore lines and compound shore lines, where many students of the subject had regarded the shore line as subsiding or even undergoing elevation. This is especially true of his studies of our South Atlantic coast. The author uses the term "tombolo," adapted from the Italian and earlier used by Gulliver, for a connecting bar which ties an island to the mainland. As this word is not yet in common use, the writer of this review should like to see Ovid's word for just such a land-tied island in the Mediterranean or the French-Indian word that is used in the Wisconsin-Michigan district introduced into our literature.

The development of the shore profile is next considered, and the validity of the theory of a marine cycle is discussed. The author here points out that we may have marine peneplains, eolian peneplains, and peneplains due to glacial action, as well as those which are the result of rain and running water. The term "monadnock," which has been defined as "an erosion remnant left standing above a peneplain made by running water," may then be subdivided, and there may be monadnocks due to the incomplete reduction or the incomplete development of a marine plain or of a wind-swept plain. The writer of this review is familiar with such an eolian peneplain extending from Kittyhawk Bay to the Kill Devil Hills on the North Carolina Coast.

The three chapters following, on the development of shore lines considered as shore lines (1) of submergence, (2) of emergence, and (3) neutral and compound shore lines, carry the burden of the author's plan and leave nothing to be desired in the wealth of material they present or in clearness of treatment. The author's familiarity with the literature of his subject and his detailed first-hand knowledge of shore lines on both sides of the Atlantic have enabled him to present here a solid and enduring piece of work.

The first of these chapters traces the systematic development of the shore line of submergence from its initial stage of extreme irregularity and complexity until it acquires the regular and simple outline characteristic of full maturity. Special consideration is given to those elements of shore form associated normally with the stages of youth and maturity, such as beaches, spits, bar bays, looped and flying bars, tombolos, cuspate bars and forelands, marsh bars, and bay deltas. The various forms discussed are illustrated by ideal diagrams and by maps of examples taken from nature. Features characteristic of the youth, maturity and old age of shore lines of emergence are then described, and special emphasis is placed on those forms which for any reason merit extended consideration. The origin of the offshore bar is fully discussed, and new evidence is presented to test conflicting theories. The history of tidal inlets is traced in some detail; and, in view of their behavior, modifications of the current explanations of offshore bar development are suggested. In a discussion of all these features, the author has held constantly in view those changes that will prove of value to the harbor engineer as well as to the geologist.

Very naturally the consideration of compound and neutral shore lines develops into a discussion of deltas. Beach ridges are also considered.

The last chapter deals with minor shore forms, such as beach cusps, ripple marks, rill marks, swash marks, shore dunes, and artificial beach cusps—all of which should interest the geologist and the engineer as well as the physiographer.

COLLIER COBB

CLIMATOLOGY AND OCEANOGRAPHY OF SOUTHWEST AFRICA

ALFRED FRANZ. **Beiträge zur Ozeanographie und Klimatologie der Deutsch-Südwestafrikanischen Küste nach Beobachtungen von S. M. S. "Möwe."** 41 pp.; maps, ills. *Aus dem Archiv der Deutschen Seewarte*, Vol. 38, 1920, No. 1. Hamburg.

The *Möwe* was used in 1911–1912 to make a survey of the 750-mile coast and narrow continental shelf of German Southwest Africa. The task was no easy one. The ship was tossed about on the large waves that impinge on this practically harborless coast. Surveying parties could hardly be landed through the heavy surf, even with the assistance of expert Togo negroes; and once ashore on the practically rainless desert there was no food or water to be had, and the low cloud or fog every night prevented sighting on stars. These conditions are typical of the desert coasts of Peru and northern Chile and to some extent also of those of Lower California, West Africa (about 12°–30° N.), and tropical Western Australia —all west coastal deserts in the trade-wind zone. The coldness of the coastal waters is responsible for the cool, foggy yet practically rainless climates of these regions. Although the diverted trade winds may blow prevailingly on-shore, the water wells up behind the seaward deflected currents and flows offshore. As the bottom current rides up the continental shelf of Southwest Africa, water at about 14° C. reaches the surface where the depth is 200 meters and at 13° C. where the depth is 150 meters. On the shore the temperature is usually above 12° if the slope of the bottom is relatively gradual, but below 12° if the bottom is steep, as off Lüderitz Bay (minima, 11.2° summer, and 9.7° winter). As the distance from the shore to the edge of the continental shelf (taken as 200 meters depth) is 25 to 60 miles, the seaward rise in water temperature is 1.5° to more than 3° in this distance (cf. R. E. Coker: Ocean Temperatures Off the Coast of Peru, *Geogr. Rev.*, Vol. 5, 1918, pp. 127–135). As would be expected, the cold water area reaches its greatest extent (9°–34° S.) and lowest temperature in August and its least extent and highest temperature in February. In the warmer months the up-welling probably continues, though the intensity of the high sun warms the water appreciably except where the up-welling is most rapid.